**Customer Lifetime Value Models**

The Customer Lifetime value is defined as expected sum of discounted future earnings, where a customer generates a profit margin for each period.



This is the CLV of customer i for the horizon h with a discount rate d and CF’s represent the net cash flow due the activity of customer i during time period k.

Many approaches use a two step scheme for this estimation:

1. Forecast the future number of Transactions of each individual
2. Then, estimate the individual average profit per transaction

The CLV is then approximated as the product of the future number of transactions and the profit per transaction discounted and summed up.

**Pareto /NBD Sub-Model and the Gamma/Gamma sub model**

As stated already, a two step scheme is employed for CLV estimation:

STEP 01: The basic Pareto/NBD model simulates two events. A Pareto Distribution determines whether a customer churns. The NBD(Negative Binomial Distribution) determine how many items a customer will order. Based on the past transactions, the parameters of the Pareto/ NBD submodel are estimated. Using the sub-models with the estimated parameters, we are able to forecast the future activity of a customer.





For description of variables and subscripts, please refer to the document linked to reference(2)

STEP 02: We use another sub-model better known as Gamma/Gamma submodel.This helps in estimating the average profit per transaction of a customer



The CLV is then approximated as the product of the future number of transactions and the profit per transaction discounted and summed up.



DATA REQUIREMENTS: The data requirements for these models is very little. The customer-by-customer approach is retained. We need only three pieces of information for every person: how many transactions they made in the calibration period(frequency), the time of their last transaction(recency) and the total time for which they were observed(tenure).

ASSUMPTIONS:

1. A probabilistic Purchasing process for Active Customers is modelled as a Poisson Process with rate λ
2. Each customer remains active during a time being exponentially distributed with death rate µ
3. Purchase rate λ for the different customers is distributed according to a Gamma Distribution across the population of the customers with shape and scale parameters as r and α
4. Death rate are distributed according to a different Gamma distribution across customers with the shape and scale parameters as β and s
5. The purchase rate λ and the death rate µ are considered as distributed independendently of each other
6. The profit per transaction is independent of the number of transactions and the expected profit per transaction does not vary over time
7. The profit from each Customer transaction is Gamma distributed with shape parameter pxi and scale parameter 1/υi (where p = Conditional Probability of the Customer being active at the present moment, = expected number of transactions made by a Customer
8. The value of υi are Gamma distributed across the population with shape parameter q and scale parameter 1/γ

**Modified Pareto/NBD Model approach**

The independence assumption between the number of transactions and the average profit per transaction is questionable. Empirical proofs in some smple datasets show that there may be some form of dependency between the number of transactions and the average profit per transaction.

For verifying this assumption of independence, we can measure the correlation, at the customer level, between the number of transactions and the average profit per transaction.

Once the dependence is established, the new estimation is done using the Pareto/dependent alternative. It is established through empirical studies that when the correlation between the number of transactions and the average profit per transaction is weak, the dependency modification does not considerably improve the model performance. But in case of strong correlations, the Pareto/Dependent clearly outperforms the Pareto/Independent approach.

This is a noticeable result, dataset having a high correlation, indicates a good ability to rank their customers by their CLV.

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**References**

1.For more details around the original Pareto/NBD models refer to [this link](http://brucehardie.com/notes/009/pareto_nbd_derivations_2005-11-05.pdf)

2.For the derivations around the modified Pareto/NBD models refer to [this link](https://www.google.com.ar/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&cad=rja&uact=8&ved=0CCEQFjAA&url=https%3A%2F%2Flirias.kuleuven.be%2Fbitstream%2F123456789%2F175502%2F1%2FKBI_0726.pdf&ei=yW2-VKW8HYH5mAXOxoHwDQ&usg=AFQjCNF9IKbZnY6yjMcx4SEzTuZDl37pMQ&bvm=bv.83829542,d.dGY)

3.For R implementation details, refer to [this link](https://www.google.com.ar/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&cad=rja&uact=8&ved=0CB8QFjAA&url=http%3A%2F%2Fcran.r-project.org%2Fweb%2Fpackages%2FBTYD%2Fvignettes%2FBTYD-walkthrough.pdf&ei=Pm2-VOHuIaHTmgWfioCoBg&usg=AFQjCNF9WivI-xajRQKsi_9WiZe4DkOITg&bvm=bv.83829542,d.dGY)